



Using Atlas 14 Data with NRCS/SCS Methodology for MnDOT projects

Dec, 2015

We all have a stake in **A  B**



Atlas 14 data with NRCS Methodology

- ▶ NRCS Hydrology methodology review
- ▶ Minnesota NRCS recommendation
- ▶ MnDOT recommendation
- ▶ Using Atlas 14 with HydroCAD



NRCS Hydrology

- ▶ NRCS – Natural Resource Conservation Service (formerly known as SCS – Soil Conservation Service) developed/support rainfall/runoff hydrology method
- ▶ NRCS uses to design small agricultural ponds, waterways and erosion control
- ▶ NRCS Hydrology methods typically used by MnDOT and most others in Minnesota when hydrograph analysis needed such as pond design
- ▶ Also used by MnDOT for peak flow for most culverts where drainage area is smaller than what recommended for StreamStats



NRCS Hydrology

- ▶ NRCS/SCS Rainfall/Runoff Hydrology Method
 - Drainage Area
 - Curve Number – based on land use and soil properties – proportion of precipitation that will runoff drainage area
 - 24 hour design precipitation
 - Time of Concentration – time for water to flow from furthest part of watershed to design point
 - Rainfall distribution – intensity of precipitation over time (24 hours)
 - Unit hydrograph – rate of flow vs time for the runoff from the watershed



Minnesota NRCS Recommendation

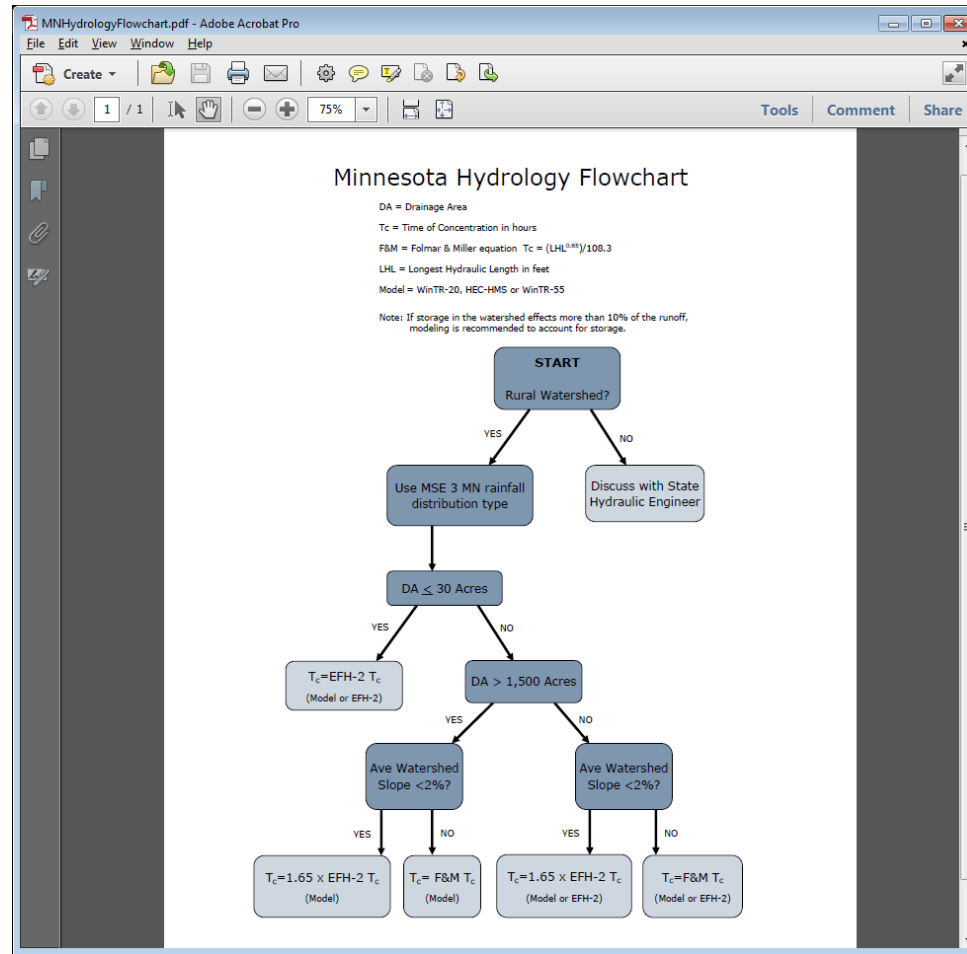
► Recommendations for NRCS Area and Field Staff for NRCS projects for rural watersheds

http://www.nrcs.usda.gov/wps/PA_NRCSCconsumption/download?cid=stelprdb1270686&ext=pdf

- Use Precipitation Depths from Atlas 14
- MSE 3 MN
 - MSE 3 rainfall distribution
 - Synthetic unit hydrograph with peak rate factor of 400
- Use Time of Concentration developed from Engineering Field Handbook (EFH2) or Folmar & Miller formula
- [Flowchart](#)



Minnesota NRCS Recommendation



MnDOT Application of NRCS Recommendation

- ▶ Tech Memo [15-10-B-02](#)
- ▶ Urban Areas
 - Stop using NRCS Type II Rainfall Distribution
 - Use Atlas 14 Rainfall Depth – from PFDS server or NRCS County File
 - Use MSE 3 or Atlas 14 Derived Rainfall Distribution
 - Use SCS Typical Unit Hydrograph (peak factor 484)
 - Use Time of Concentration formulas from Drainage Manual/TR-55
 - Route flow (hydrograph analysis) where have storage



MnDOT Application of NRCS Recommendation

► Rural Areas

- Stop using NRCS Type II Rainfall Distribution
- Use Atlas 14 Rainfall depth
- Use MSE 3 or Atlas 14 Derived Rainfall Distribution
- Use standard dimensionless unit hydrograph with peak factor of 484 unless conditions on following slide met.
- Route flow (hydrograph analysis) if significant storage, especially right upstream of crossing.



MnDOT Application of NRCS Recommendation

- ▶ Rural Areas – cont'd
 - Minnesota NRCS recommended methodology
 - MSE 3 rainfall distribution
 - Unit Hydrograph with peak factor of 400
 - Time of Concentration methods per NRCS flowchart
 - MN NRCS MSE 3 MN and Time of Concentration methodology may be used for some rural drainage areas when all of the following conditions are met:
 - Drainage area is rural
 - Drainage area is not steep
 - Predicted flows are consistent with historical observations at the site.



Using Atlas 14/NRCS resources in HydroCAD

Rainfall Depth – use either method below:

- ▶ Import rainfall depths from Atlas 14 PFDS server – helpsheet on web site
- ▶ NRCS County file – included with HydroCAD 10 Build 15 or higher – slides to follow

Rainfall Distribution – use either method below:

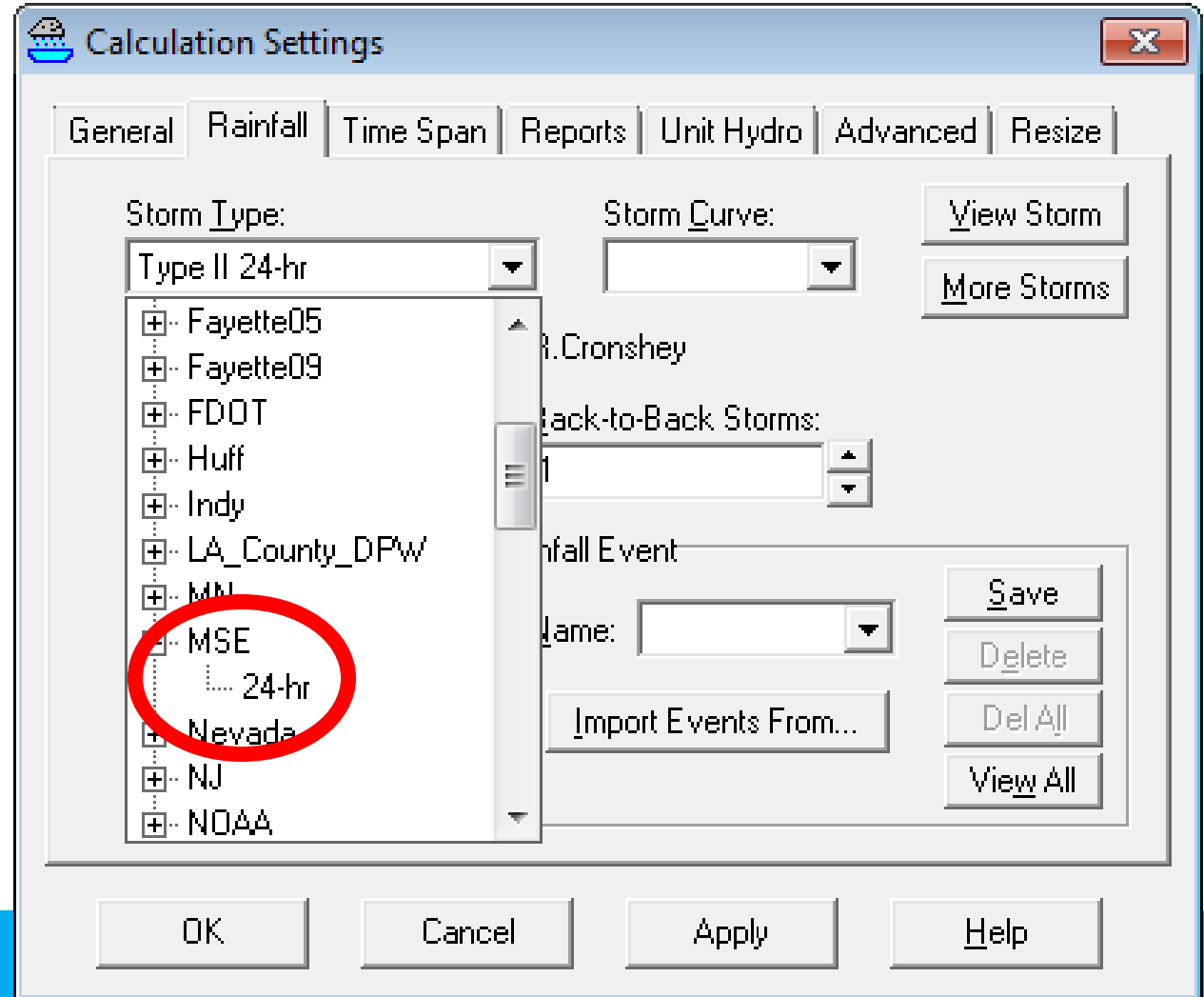
- ▶ Import rainfall distribution from Atlas 14 PFDS server – helpsheet on web site
- ▶ NRCS MSE 3 rainfall distribution included with HydroCAD 10 Build 14 or higher – slides to follow



Selecting NRCS MSE-3 Rainfall Distribution in HydroCAD

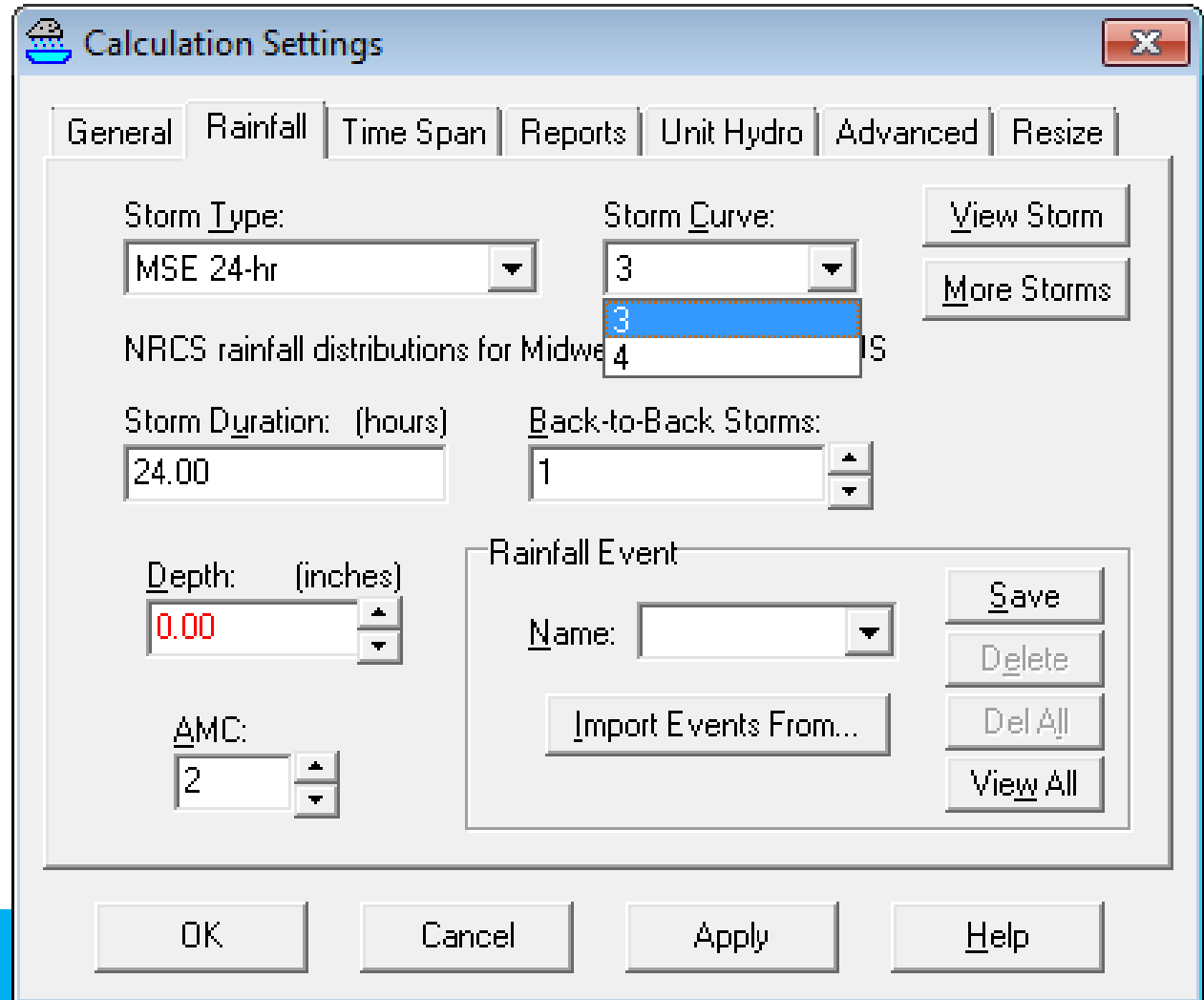
Select
Calculation
Settings
Dialog and
select Rainfall
Tab

Select
MSE 24-hr as
Storm Type



Selecting NRCS MSE-3 Rainfall Distribution in HydroCAD

- ▶ Then select Storm Curve 3



The image shows the 'Calculation Settings' dialog box in HydroCAD, with the 'Rainfall' tab selected. The 'Storm Type' is set to 'MSE 24-hr'. The 'Storm Curve' dropdown is open, showing a list of NRCS rainfall distributions for Midwest, with '3' selected. The 'Storm Duration' is 24.00 hours, and 'Back-to-Back Storms' is 1. The 'Depth' is 0.00 inches, and the 'AMC' is 2. The 'Rainfall Event' section is empty. The 'View Storm' and 'More Storms' buttons are visible. The 'OK', 'Cancel', 'Apply', and 'Help' buttons are at the bottom.

Calculation Settings

General | **Rainfall** | Time Span | Reports | Unit Hydro | Advanced | Resize

Storm Type: MSE 24-hr Storm Curve: 3 View Storm
NRCS rainfall distributions for Midwest More Storms

Storm Duration: (hours) 24.00 Back-to-Back Storms: 1

Depth: (inches) 0.00 AMC: 2

Rainfall Event

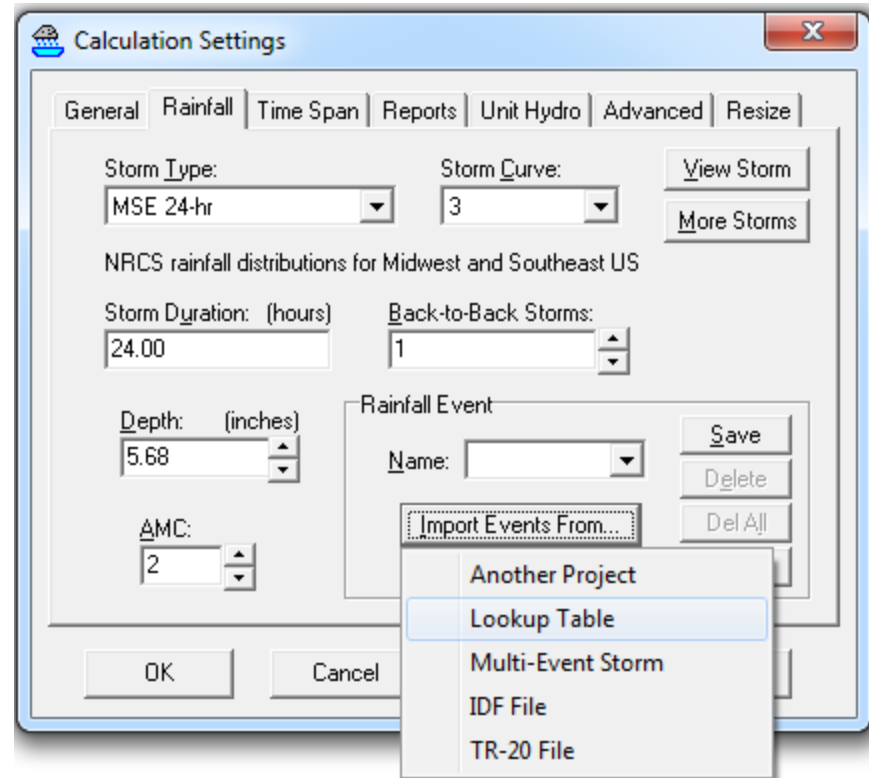
Name: Save
Delete
Import Events From... Del All
View All

OK Cancel Apply Help

Select 24 hour rainfall depth from HydroCAD Lookup File

On Calculation Settings dialog/Rainfall Tab

- Go to Rainfall Event and click on **Import Events From** button
- Select **Lookup Table**



Select 24 hour rainfall depth from HydroCAD Lookup File

On Rainfall Event Lookup Table:

1. Select Event Lookup File
Atlas-14-Rain.txt

2. Find State = MN

3. Scroll down
and find county

4. Click on OK

Rainfall Event Lookup

To define rainfall events, select location and click OK

Event Lookup File: Atlas-14-Rain.txt

Find State: MN

ID	State	County	Storm	1-Year [inches]	2-Year [inches]	5-Year [inches]	10-Year [inches]	25-Year [inches]	50-Year [inches]	100-Year [inches]
454	MN	Rock	Type II,MSE_3	2.36	2.77	3.47	4.09	4.97	5.69	6.44
462	MN	Roseau	Type II,MSE_3	1.98	2.28	2.86	3.41	4.27	5.02	5.85
495	MN	Scott	Type II,MSE_3	2.48	2.85	3.54	4.22	5.30	6.25	7.29
494	MN	Sherburne	Type II,MSE_3	2.39	2.79	3.48	4.11	5.04	5.81	6.63
492	MN	Sibley	Type II,MSE_3	2.43	2.82	3.52	4.17	5.17	6.03	6.95
486	MN	St Cloud	Type II,MSE_3	2.32	2.70	3.38	3.99	4.91	5.68	6.51
496	MN	St Louis	Type II,MSE_3	2.12	2.47	3.08	3.63	4.46	5.14	5.87
490	MN	Stearns	Type II,MSE_3	2.32	2.70	3.38	3.99	4.91	5.68	6.51
489	MN	Steele	Type II,MSE_3	2.48	2.91	3.70	4.44	5.57	6.55	7.61
469	MN	Stevens	Type II,MSE_3	2.22	2.56	3.17	3.72	4.53	5.21	5.93
487	MN	Swift	Type II,MSE_3	2.30	2.64	3.28	3.86	4.76	5.52	6.34
473	MN	Todd	Type II,MSE_3	2.27	2.65	3.33	3.94	4.85	5.61	6.41
485	MN	Traverse	Type II,MSE_3	2.17	2.83	3.16	3.72	4.53	5.20	5.90
478	MN	Wabasha	Type II,MSE_3	2.55	2.95	3.72	4.47	5.65	6.68	7.81
483	MN	Wadena	Type II,MSE_3	2.23	2.58	3.24	3.85	4.81	5.63	6.52
482	MN	Waseca	Type II,MSE_3	2.50	2.92	3.69	4.41	5.52	6.46	7.49
481	MN	Washington	Type II,MSE_3	2.44	2.88	3.48	4.18	5.28	6.18	7.28

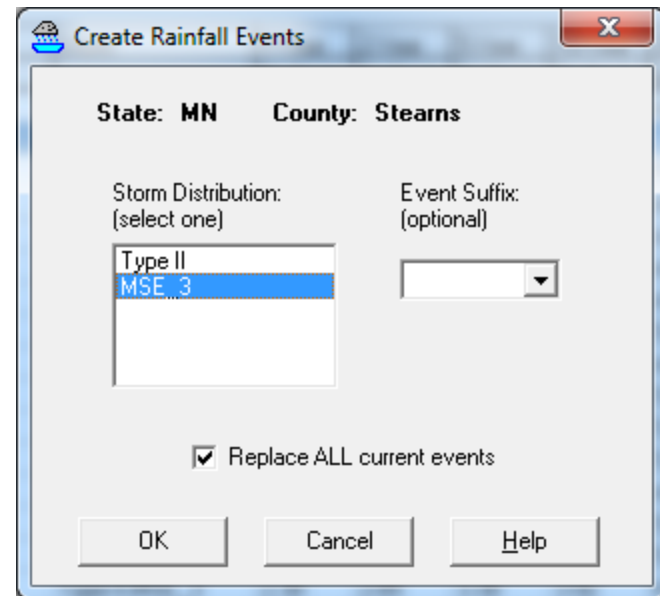
OK Cancel Help



Select 24 hour rainfall depth from HydroCAD Lookup File

Select MSE 3 as Storm Distribution and OK

Data is from Minnesota NRCS County file and is the spatially averaged value for the county.



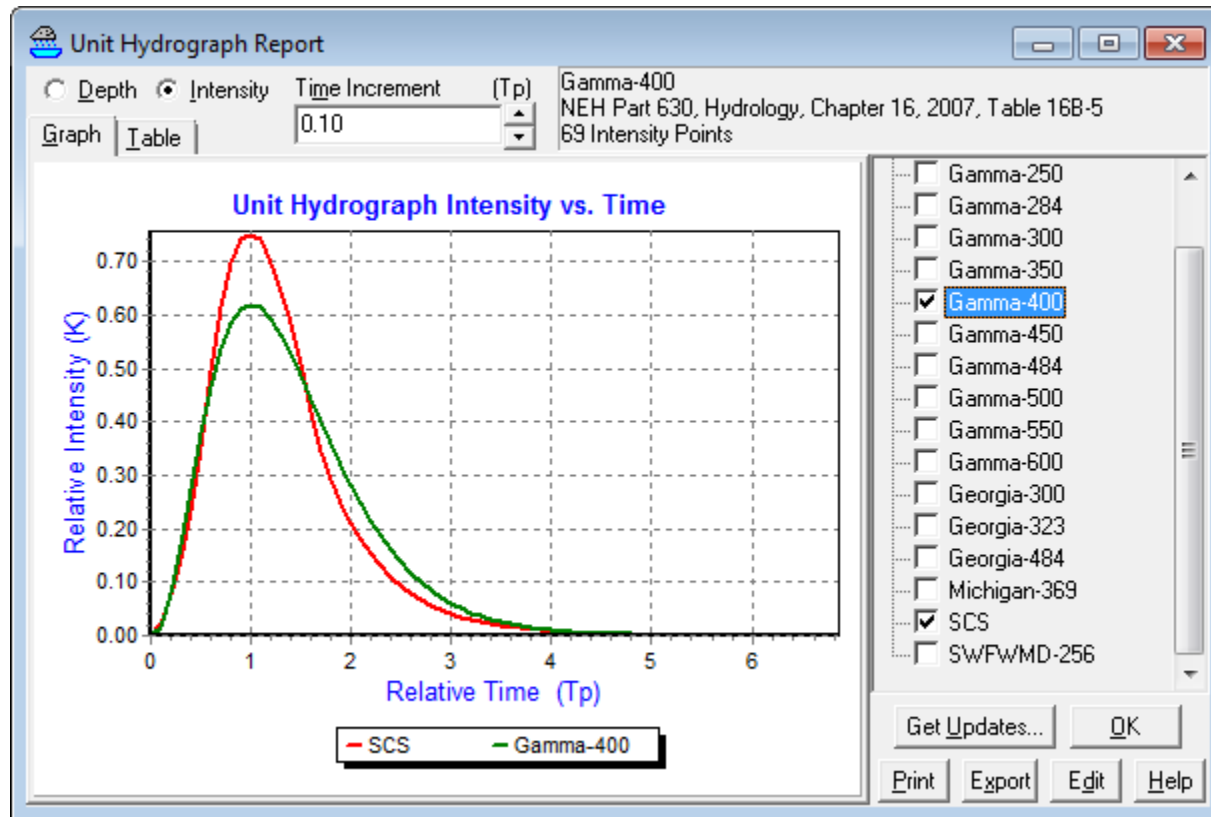
Using NRCS Recommendations in HydroCAD – MSE 3 Rainfall Distribution

Rainfall Distribution	Peak Flow
Atlas 14	162 cfs
NRCS – MSE3	167 cfs
SCS Type II	151 cfs

- ▶ Stearns County
- ▶ Drainage Area = 100 acres
- ▶ $T_c = 64$ minutes
- ▶ $CN = 75$
- ▶ 24 hour Rainfall = 5.68 in



Minnesota NRCS – Unit Hydrograph

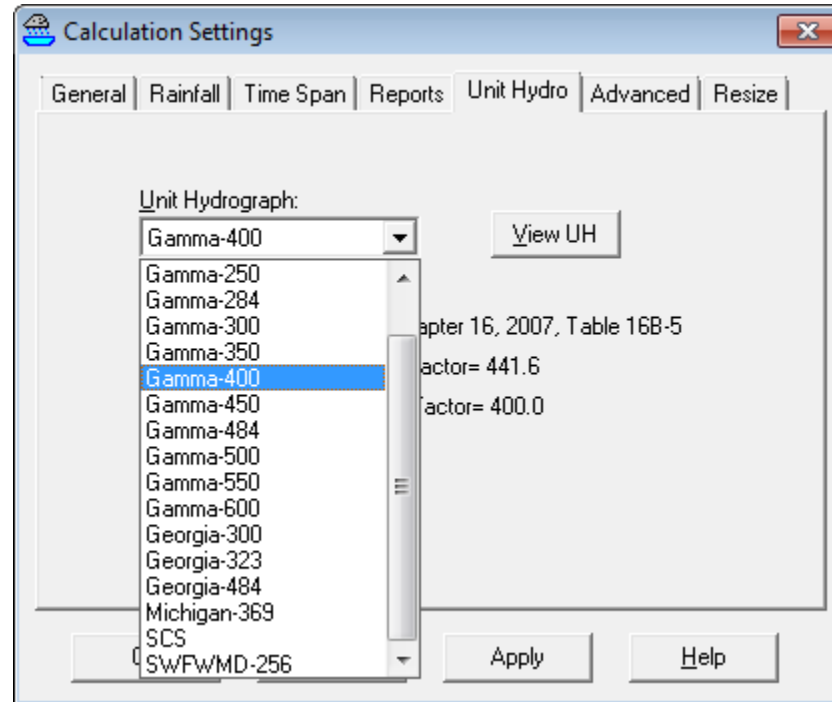


Selecting Peak Factor 400 Unit Hydrograph in HydroCAD

SCS is the default

Select peak factor 400 dimensionless unit hydrograph by going to

Settings >
Calculation >
Unit Hydro



Impact of Unit Hydrograph

Rainfall Distribution	Peak Flow – SCS Unit hydrograph (Peak Factor 484)	Peak Flow – NRCS Peak Factor 400
Atlas 14	162 cfs	
NRCS – MSE3	167 cfs	145 cfs MSE3 MN
SCS Type II	151 cfs	

- ▶ Stearns County
- ▶ $T_c = 64$ minutes
- ▶ $CN = 75$
- ▶ 24 hour Rainfall = 5.66 in



Review Options in Summary!

Subcat 1S: NRCSEExample - NRCS_Example

Summary Hydrograph Events

Runoff = 144.52 cfs @ 12.91 hrs, Volume= 23.446 af, Depth> 2.81"

Runoff by SCS TR-20 method, UH=Gamma-400, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 Rainfall=5.66"

Area (ac)	CN	Description
* 100.000	75	
100.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
64.2					Direct Entry, F&M

Table
Shrink
Print
Export
Edit
Help



Using NRCS Methodology in HydroCAD – versions

- ▶ HydroCAD 10 build 15
 - Includes county data file that includes Atlas 14 data for Minnesota counties
- ▶ HydroCAD 10 build 14 or higher
 - Includes MSE 3 rainfall distribution
- ▶ HydroCAD 10 – build prior to 14
 - Can import Atlas 14 rainfall distribution downloaded from PFDS server
 - Includes unit hydrograph with peak factor 400
- ▶ HydroCAD version 9
 - Can not import Atlas 14 rainfall distribution
 - Need to develop a custom rainfall distribution for MSE 3 based on data from NRCS



Impact of Rainfall Distribution/Unit Hydrograph

- ▶ For Peak Flow method – most impact for areas with shorter Time of Concentration
- ▶ If route flow, especially if have significant amounts of storage, the unit hydrograph and rainfall distribution used have much less impact



Recommendations

- ▶ Stop using NRCS Type II rainfall distribution
- ▶ Use Atlas 14 derived distribution or MSE-3 distribution
- ▶ For urban watersheds – continue to dimensionless unit hydrograph with peak factor of 484 (default in HydroCAD)
- ▶ **Document what is used**



Recommendations

- ▶ Allowable to use NRCS Recommended Method for rural areas – MSE 3 MN
 - MSE 3 Rainfall Distribution
 - Unit Hydrograph with peak factor 400
- ▶ Use engineering judgment and continue to use typical SCS unit hydrograph (PF 484) where higher design flow justified:
 - Rural vs Agricultural
 - Climate Change resilience
 - No Storage
 - History of Flooding
 - Critical locations
 - Steepness/flashiness

